without losing much of it in the water that is draining away.

The deposits of DDT on glass were extremely resistant to water applied as drops similar to rainfall. The effect on the surface of an apple was more difficult to observe precisely, but there was no evidence that the DDT washed off the apples any more readily than from the glass. Some nascent precipitate of DDT from acetone spray on glass was not visibly decreased after 7 hours of pounding from rapidly dropping water.

Some of the advantages of using a multispray process over the spraying of a concentrated DDT solution alone may be revealed after the practical trials. At present it appears that inclusion of the water spray in the process should be useful as a carrying medium in orchard or truck-crop spraying. The presence of water should also decrease the danger of injury to foliage.

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MARKING ANOPHELES MOSQUITOES WITH FLUORESCENT COMPOUNDS[1]

MANY investigations concerned with activities and life cycles of *Anopheles* mosquitoes, as well as other insects, necessitates marking specimens in such a manner that individuals so marked can be recognized when subsequently collected and examined. Methods previously used employed dyes, either in solution or in the form of small particles, and metallic dusts.[2] When these methods are used, individual specimens have to be handled when search of collections is made for marked specimens. This procedure is very time-consuming.

The method herein presented involves the use of fluorescent compounds for marking adult specimens of *Anopheles quadrimaculatus* Say and later detecting those marked under an ultra-violet light. Anthracene, rhodamine B and fluorescein which produce blue, red and green fluorescent colors, respectively, have been successfully used as outlined below.

Anthracene can be applied as an aerosol or as a dust mixed with gum arabic. The aerosol is made by vaporizing anthracene with heat into a closed chamber. Particles with a mean diameter of 6.7 microns are produced. Exposure of caged specimens for five minutes to an aerosol concentration of 10.0 milligrams per liter of air produces an homogenous deposit of particles on the exoskeleton. This treatment apparently does not harm the specimens in any way.

When used as a dust, anthracene is mixed with gum arabic in water in the ratio of 1 part anthracene to 2 parts gum arabic. The mixture is evaporated to dryness and ground to a powder. Specimens are dusted with the powder and then placed in an atmosphere of saturated humidity for 15 minutes. This causes the particles to deliquesce and adhere to the insects. The use of gum arabic as a diluent provides a firm adhesion, thus contamination of unmarked specimens in the process of collection is avoided.

Rhodamine B and water-soluble fluorescein can be used to dye gum arabic at a concentration of 10.0 milligrams of dye to 3.0 grams of gum arabic. The resulting mixture is used as the anthracene dust for marking specimens, as indicated above.

By the use of this method large numbers of individuals can be readily marked and the examination of several hundred specimens can be made in a matter of a few minutes. Further details of this method will be given in a later publication.

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DISCUSSION

ANTIBACTERIAL ACTION OF QUINONES

WITH reference to the introductory statement by Colwell and McCall in their article in SCIENCE for June 8, page 592, that "the antibacterial activity of quinones has been recognized since 1911," I wish to remark that this property of quinones was made use of by me for preventing the bacterial decomposition of sugar-cane juice in 1906, in a study upon the action of the oxidases of cane juice on various polyphenols. I qoute as follows from my article on "The Fermentation of Sugar-Cane Products":[1]

> If certain polyphenols, such as hydroquinone, or pyrogallol, are added to fresh cane juice, a rapid oxidation of these compounds is produced with an intense darkening of the juice. The latter takes on at the same time a peculiar odor, due to the formation of a quinone body, and what is more remarkable acquires a germicidal property which, in the case of the juice treated with hydroquinone, insures its preservation for weeks. Sterilized juice shows no change in color and develops no germicidal properties with any of the phenol bodies named. In connection with this oxidation of hydroquinone there is a very marked absorption of oxygen.

Other experiments in my article tended to show that the familiar darkening in color of expressed

[1] From Emory University Field Station, Newton, Georgia.

[2] D. E. Eyles, *Public Health Bulletin*, No. 287, 39 pp., 1944.

[1] *Jour. Amer. Chem. Soc.*, April, 1906, pp. 455–6.

cane juice and its incipient slight germicidal action are due to the action of the oxidases of the juice upon naturally occurring polyphenols of a tannin nature with production of quinone-like substances. The discoloration is more evident when freshly cut sections of the sugar-cane are exposed to the air and this leads to the suggestion that this reaction may serve a useful purpose in protecting living plants to a certain extent against the invasion of micro-organisms when their inner tissues are exposed to the air as a result of injury. The antibacterial activity of quinones was very likely known before the year 1906, but I am unable at the moment to refer to previous observations recorded in the literature.

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GREEN COLOR OF PLANT ASH DUE TO MANGANESE, NOT TO COBALT

IN 1932, Bishop and Lawrenz[1] published a note on the presence of cobalt in plant ash. Their attention was called to the problem by the color of the ash which was white from some plants but of various shades of green from others. Iron, chromium, manganese, cobalt, nickel and copper were considered as possible causes of this green color. Using the magneto-optical method of analysis it was concluded that cobalt was responsible for the green color of the ash. This has been widely quoted as evidence of cobalt in plants.[2]

In general plants contain but a fraction of a part per million (dry weight basis) of cobalt. The manganese content, however, is commonly over fifty parts per million and may reach as high as 4,300 parts per million manganese in tree leaves growing on acid soil.

From the evidence adduced from the color and composition of the ash from several thousand of plant ash analyses, and from the color of ignited soil extract residues we can state quite positively that the cause of the green color of plant ash is due to manganese. However, to develop this color it is necessary that the ash be thoroughly oxidized, heated at a fairly high temperature and that the ash be relatively high in potassium (or sodium) carbonate. Under these conditions green potassium manganate is formed. The green color developed is the classical and time-honored qualitative test for manganese by fusion with sodium or potassium carbonate under oxidizing conditions. It is a very sensitive qualitative test. Plant ash frequently contains enough manganese to develop the colors, when treated with water, which are characteristic of chameleon mineral.

[1] SCIENCE, 75: 1940, 264–5.

[2] L. G. Willis, "Bibliography of the Minor Elements," third edition, p. 281, 1939.

If green plant ash is leached with water, a green solution is obtained. This solution turns pink when neutralized with hydrochloric acid, as Bishop and Lawrenz state. This is characteristic of manganese and not of cobalt. The cobalt of plants is far too low to yield these colors. Further, it is doubtful if any cobalt would go into solution in a water extract of plant ash because cobalt is not dissolved by a slight excess of alkali except under unusual conditions such as in the presence of ammonia. The large excess of phosphate in plant ash would also tend to prevent the cobalt from dissolving in water.

The addition of quantities of cobalt up to five parts per million, the highest quantity plants seem to contain, has no noticeable effect on the color except in the case of plants high in aluminum such as the sweet leaf. In this case the change in color is the development of a faint shade of blue rather than green.

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THE COLOR REACTION OF VITAMIN A ON ACID EARTHS

A BRIGHT blue color reaction of vitamin A upon adsorption on a commercial adsorbent made from Montmorillonite was lately described by Lowman[1] and, in a recent issue of this journal, Zechmeister and Sandoval[2] point out that a similar observation had been previously reported by Meunier.[3] However, this observation goes further back; in 1939 Emmerie and Engel[4] discovered that vitamin A gives a dark blue color, and carotenoids a bluish green color, when adsorbed on Floridin SX used for the removal of vitamin A and carotenoids from serum extracts prior to the reductometric colorimetry of tocopherol. When adapting the method of Emmerie and Engel to a photoelectric procedure, we confirmed their observation and described[5] that a clear yellow benzene solution containing, besides tocopherol, vitamin A and carotenoids caused a column of floridin earth to assume a dark greenish blue color.

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[1] A. Lowman, SCIENCE, 101: 183, 1945.

[2] L. Zechmeister and A. Sandoval, *ibid.*, 101: 585, 1945.

[3] P. Meunier, *Comptes rendus de l'Acad. Franc.*, 215: 470, 1942.

[4] A. Emmerie and C. Engel, *Rec. trav. chim. Pays-Bas*, 58: 283, 1939.

[5] G. Gernsheim Mayer and H. Sobotka, *Jour. Biol. Chem.*, 143: 695, 1942.